

a what is claimed is:~~Claims~~

1. A method of welding two or more overlapping members having a tenacious surface oxide layer, the method comprising the steps of:
- 5 melting said members at a predetermined location to form a weld pool; and
- disturbing the weld pool by introducing a disturbing member into the weld pool.
- 10 2. A method as claimed in claim 1, wherein the step of melting the members to form the weld pool is achieved by using a plasma arc torch.
3. A method as claimed in claim 1 or claim 2, and including the step of clamping the overlapping members prior to forming the weld pool.
- 15 4. A method as claimed in any preceding claim, wherein the disturbing member is consumable.
5. A method as claimed in claim 4, wherein the disturbing member has a composition the same or similar to that of the metal forming the two or more members.
- 20 6. A method as claimed in any preceding claim, wherein the step of disturbing the weld pool comprises the steps of advancing the disturbing member into the weld pool at a predetermined rate and to a predetermined depth, and then withdrawing the disturbing member at a predetermined rate.
- 25 7. A method as claimed in claim 6, and including the intermediate step of holding the disturbing member in the weld pool for a predetermined time.
- 30 8. A method as claimed in claim 6 or claim 7, wherein the speed of advance and withdrawal of the disturbing member is variable.
9. A method as claimed in claim 8, wherein, the speed of withdrawal is
- 35 equal to or faster than the speed of advance.

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10. A method as claimed in any of claims 1 to 3, wherein the disturbing member is non-consumable.
- 5 11. A method as claimed in claim 10, wherein the disturbing member is made from a material which is not wetted by the molten metal of the weld pool.
- 10 12. A method as claimed in claim 10 or 11, wherein the step of disturbing the weld pool comprises the steps of advancing the disturbing member into the weld pool at a predetermined rate and to a predetermined depth, and then withdrawing the disturbing member.
13. A method as claimed in claim 12, and including the intermediate step of holding the disturbing member in the weld pool for a predetermined time.
- 15 14. A method as claimed in any preceding claim, wherein the movement of the disturbing member is at a relatively shallow angle to the plane of the weld.
15. A method as claimed in claim 14, wherein the angle is above 30°.
- 20 16. A method as claimed in claim 14 or claim 15, wherein the angle is up to 45°.
- 25 17. A method as claimed in any preceding claim, wherein the disturbing member is introduced into the weld pool to one side thereof to promote a stirring effect.
18. A method as claimed in claim 17, wherein two or more disturbing members are provided to promote such stirring.
- 30 19. A method as claimed in any preceding claim, the method including disturbance of the weld pool by a welding gas.
20. A method as claimed in claim 19 when dependant upon claim 2, the method including disturbance of the weld pool by the action of a shielding gas.
- 35 21. A method as claimed in claim 19 when dependent upon claim 2, or claim 20, the method including disturbance of the weld pool by the action of a plasma gas.

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22. A method as claimed in any of claims 19 to 21, wherein the gas is caused to impinge on the weld pool at an angle and in a manner so as to promote swirling of the weld pool.
- 5 23. A method as claimed in any of claims 19 to 22, wherein the gas has a rotational component achieved by rifling in a gas delivery jet or nozzle.
- 10 24. A method as claimed in any preceding claim, wherein the weld pool is supported from beneath.
25. A method as claimed in claim 2, wherein the step of disturbing the weld pool includes disturbance by pulsing a welding current of a plasma arc torch.
- 15 26. A welding apparatus for welding two or more overlapping members having a tenacious surface oxide layer, the apparatus comprising a plasma arc torch operable to form a weld pool in a work piece, and weld pool disturbing means operable, in use, to disturb a weld pool formed by the plasma arc torch, the weld pool disturbing means comprising a disturbing member which is
- 20 movable into the weld pool.
27. An apparatus as claimed in claim 26, and including a weld pool supporting member.
- 25 28. An apparatus as claimed in claim 26 or claim 27, wherein the disturbing member is consumable.
- 30 29. An apparatus as claimed in claim 28 wherein the disturbing member comprises a wire or filament having a composition the same or similar to that of the workpiece.
30. An apparatus as claimed in claim 29, wherein the wire or filament is movable by a feed mechanism.
- 35 31. An apparatus as claimed in claim 30, wherein the feed mechanism is operable to move the wire or filament at one or more predetermined feed rates relative to the weld pool, in use.

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32. An apparatus as claimed in claim 30 or claim 31, wherein the feed mechanism includes guide means to guide the wire or filament to a predetermined location in the weld pool.
- 5 33. An apparatus as claimed in claim 26 or claim 27, wherein the disturbing member is non-consumable.
34. An apparatus as claimed in claim 33 wherein the disturbing member comprises a lance or like implement.
- 10 35. An apparatus as claimed in claim 34, wherein the disturbing member is made from a material which is not wetted by the molten metal of the weld pool.
36. An apparatus as claimed in claim 37, wherein the support member comprises a support surface having a recess adapted to support the weld pool.
- 15 37. An apparatus as claimed in claim 36, wherein the support member is adapted to allow the recess to vent when the weld pool is formed.
- 20 38. An apparatus as claimed in claim 36 or 37, wherein the support surface is provided with one or more open channels extending from the recess.
39. An apparatus as claimed in any of claims 36 to 38, the support member comprising a body having an insert, the insert defining the support surface, wherein the insert is manufactured from a material having a lower thermal conductivity than the material of the body.
- 25 40. An apparatus as claimed in claim 39 wherein the insert is a ceramic material.
- 30 41. An apparatus as claimed in claim 39 wherein the insert is electrically conductive.
42. An apparatus as claimed in claim 41 wherein the insert is a graphite-based material.
- 33 43. An apparatus as claimed in any of claims 36 to 42, wherein the support member is provided with a cooling system.

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44. An apparatus as claimed in claim 43, wherein the support member has a substantially hollow interior through which coolant is circulatable.
- 5 45. An apparatus as claimed in any of claims 36 to 38, wherein the support member has a peripheral raised edge against which the work piece is received.
46. An apparatus as claimed in claim 45, wherein the edge is discontinuous...
- 10 47. An apparatus as claimed in any of claims 26 to 46, wherein the plasma arc torch and supporting member are movable relative to one another so as to enable the work piece to be clamped therebetween.
- 15 48. An apparatus as claimed in any of claims 26 to 47, wherein an electric welding current of the plasma torch is pulsable during welding in order to assist disturbance of the oxide layer

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